Developing of a Novel Integrated MCDM MULTIMOOSRAL Approach for Supplier Selection

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Abstract. The main aim of the article is to propose a new multiple criteria decision-making approach for selecting alternatives, the newly-developed MULTIMOOSRAL approach, which integrates advantages of the three well-known and prominent multiple-criteria decision-making methods: MOOSRA, MOORA, and MULTIMOORA. More specifically, the MULTIMOOSRAL method has been further upgraded with an approach that can be clearly seen in the well-known WASPAS and CoCoSo methods, which rely on the integration of weighted sum and weighted product approaches. In addition to the above approaches, the MULTIMOOSRAL method also integrates a logarithmic approximation approach. The expectation from the development of this method is that the integration of several approaches can provide a much more reliable selection of the most appropriate alternative, which can be very important in cases where the performance of alternatives obtained by using some other method does not differ much. Finally, the ranking of alternatives based on the dominance theory, used in the MOORA and MULTIMOORA methods, is replaced by a new original approach that should allow a much simpler final ranking of alternatives in order to reach a stronger result with five different techniques. The suitability and efficacy of the proposed MULTIMOOSRAL approach are presented through an illustrative case study of the supplier selection.

Key words: MOOSRA, MOORA, MULTIMOORA, logarithmic approximation, MULTIMOOSRAL, MCDM.

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1. Introduction

The increasing competitiveness and complexity of the market, the accelerated development of information and communication technologies have caused the decision-making process in many organizations to become of crucial and decisive importance. Decision-making involves human judgments and logic. Therefore, increasingly complex business conditions require a multi-criteria approach to solving business problems, which allows an objective comparison of several alternatives evaluated in a system of multiple heterogeneous and different criteria with other extremization requirements and different relative importance. Consequently, multi-criteria decision-making (MCDM) methods are useful for facilitation of decision-making process in situations when there are a number of often conflicting criteria (Karamaşa *et al.*, 2020; Stanujkic *et al.*, 2019). Hafezalkotob *et al.* (2019a) emphasizes three categories of the MCDM techniques, such as: Value Measurement Methods (the SAW method; the WASPAS method etc.); Goal or Reference Level Models (the VIKOR method, the TOPSIS method etc.); and Outranking Techniques (the ELECTRE method; the PROMETHEE method etc.).

Accelerated growth and the existence of numerous methods of multi-criteria decision-making can improve the decision-making process in all areas of life. Solving problems by utilizing MCDM is based on quantitative analyses and represent elegant solutions when making decisions between multiple alternatives based on multiple-criteria. Therefore, in due course of time, there are prominent and most common developed MCDM methods, among the dozens of approaches proposed over time for solving complex-decision making problems, such as the Maxmax method, the Maxmin method, the SAW method, the AHP method, the ELECTRE method, the PROMETHEE method, the TOPSIS method, the VIKOR method, the COPRAS method, the MACBETH method, the ANP method, the MOORA method, the MULTIMOORA method, and so forth (Zavadskas *et al.*, 2020; Ulutaş *et al.*, 2020; Jauković-Jocić *et al.*, 2020).

The need to solve as wide a range of real-world problems has led to the creation of a new generation of MCDM methods and approaches, such as: the HEBIN method (Zavadskas *et al.*, 2021); the MARCOS method (Stević *et al.*, 2020); the CoCoSo method (Yazdani *et al.*, 2019); the SECA method (Keshavarz-Ghorabaee *et al.*, 2018); the FUCOM method (Pamučar *et al.*, 2018); the ARCAS (Stanujkic *et al.*, 2017a); the PIPRECIA method (Stanujkić *et al.*, 2017b); the MABAC method (Pamučar and Ćirović, 2015); the EDAS method (Keshavarz Ghorabaee *et al.*, 2015), and so forth. Some of the aforementioned methods were used for ranking of alternatives whereas some of them for the purpose of weight determination.

The MOOSRA method (Multi-Objective Optimization on the basis of Simple Ratio Analysis) belongs to the group of multi-objective optimization methods and is developed by Brauers (2004). The main difference between the MOOSRA method and the MOORA method is reflected in the negative performance scores that do not appear in the MOOSRA method, unlike the MOORA method. Besides, the MOOSRA method is less sensitive to the large variation in the values of the criteria (Adalı and Işık, 2017). So far, the MOOSRA method has been applied for solving of a various complex decision-making problems,

such as: the laptop selection problem (Adalı and Işık, 2017); project-critical path selection (Dorfeshan *et al.*, 2018); bio-medical waste disposal assessment (Narayanamoorthy *et al.*, 2020); machine selection (Sarkar *et al.*, 2015), and so forth. The simplicity of the calculation procedure of the MOOSRA method, which is based on the ratio between weighted ratings of beneficial and non-beneficial criteria, can be mentioned as an important characteristic of this method.

Brauers (2004) also developed the MOORA method (Multi-Objective on the basis of Ratio Analysis). Somewhat later, based on the ideas of the MOORA method, Brauers and Zavadskas (2010) have proposed the MULTIMOORA method (Multi-Objective Optimization by Ratio Analysis plus Full Multiplicative Form). Both methods have been proposed to cope with subjectivity problems. The usability of the MOORA method has been demonstrated in numerous cases, such as: credit evaluation model using MOORA method (İç, 2020); evaluation of the work performance (Fadli and Imtihan, 2019); decision-making in the production system (Attri and Grover, 2014); supplier selection (Karande and Chakraborty, 2012); decision-making in a manufacturing environment (Chakraborty, 2011); privatization in a transition economy (Brauers and Zavadskas, 2006), and so on. When it comes to the MULTIMOORA method, the same has also been applied in various and numerous cases, such as: personnel selection (Karabasevic *et al.*, 2015; Baležentis *et al.*, 2012); risk assessment (Liu *et al.*, 2014); project management (Brauers and Zavadskas, 2010); strategy assessment (Fedajev *et al.*, 2020); ranking of the renewable energy sources (Alkan and Albayrak, 2020); site selection (Rahimi *et al.*, 2020); hybrid vehicle engine selection (Hafezalkotob *et al.*, 2019b), and so on. Integration of several proven multicriteria approaches for ranking alternatives and the use of dominance theory for the final ranking of alternatives can be mentioned as an important characteristic of these methods, which is also proven in the above-mentioned articles.

The main motivation of this research is to develop a new simpler and much more reliable MCDM approach for selecting alternatives. Accordingly, the paper aims to propose a new MCDM-based technique that is based in some segments on previous well-known MCDM techniques (MOOSRA, MOORA, MULTIMOORA), and as a novelty also includes the logarithmic approximation (LA) approach. Therefore, it is also important to state that there are four arithmetic operations in the proposed MULTIMOOSRAL method. These are as follows: addition, subtraction, multiplication, and division. In addition to these arithmetic operations, a fifth evaluation technique, which is the logarithmic approach has been added to the MULTIMOOSRAL method. Thus, unlike other methods (MULTIMOORA, MOORA, and MOOSRA), the MULTIMOOSRAL method was tried to reach a stronger result with five different techniques. For example, MULTIMOORA method uses only three arithmetic operations, which are subtraction, division, and multiplication. On the other hand, MOORA and MOOSRA use only two arithmetic operations. However, the MULTIMOOSRAL method uses all arithmetic operations and a logarithmic approach to reach much more valid and rigorous results.

Further, highlights of the logarithmic normalization are emphasized by Zavadskas and Turskis (2008). Therefore, the newly-developed, so-called MULTIMOOSRAL method integrates five approaches for ranking alternatives. In order to apply and test the new approach, an illustrative case study of the supplier selection is conducted. Accordingly, the

paper is structured as follows: in Section 1, the introductory consideration are given. In Section 2, the MOOSRA method, the MOORA method and the MULTIMOORA method are presented. The new MULTIMOOSRAL approach is presented in Section 3, whereas in Section 4, a conducted case study is demonstrated. Finally, at the end of the article, conclusions are given.

2. Methodology

2.1. *The MOOSRA Method*

The overall performance score of each alternative v_i in the MOOSRA method is calculated as follows Kumar and Ray (2015):

$$v_i = \frac{\sum_{j \in \theta_{\max}} w_j r_{ij}}{\sum_{j \in \theta_{\min}} w_j r_{ij}}, \tag{1}$$

where w_j denotes weight of criterion j, r_{ij} denotes normalized rating of alternative i in relation to criterion j, $\theta_{\max}$ and $\theta_{\min}$ denote set of beneficial and set of non-beneficial criteria.

The MOOSRA method uses vector normalization procedure for normalization as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} (x_{ij})^2}}, \tag{2}$$

where x_{ij} denotes rating of alternative i in relation to criterion j, and m denotes the number of alternatives.

In the MOOSRA method, the alternatives are ranked on the basis of values of v_i in descending order, and the alternative with a higher value of v_i is the most preferable.

2.2. *The MOORA Method*

The MOORA method combines two approaches to ranking alternatives. The first approach, named the Ratio System (RS) approach, calculates the difference between the ratings of beneficial and non-beneficial criteria as follows:

$$y_i = \sum_{j \in \theta_{\max}} w_j r_{ij} - \sum_{j \in \theta_{\min}} w_j r_{ij}, \tag{3}$$

where y_i denotes an overall importance of the alternative i.

The alternative with a higher value of y_i is the most appropriate alternative in this approach, i.e. alternatives are ranked based on y_i in descending order.

The second approach, named the Reference Point (RP) approach, is based on Tcheby-cheff Min–Max metric. A maximal distance between alternative and the reference point t_i is determined as follows:

$$t_i = \max_j \left(w_j \left| r_j^* - r_{ij} \right| \right), \tag{4}$$

where r_j^* denotes jth coordinate of reference point, and it is determined as follows:

$$r_j = \begin{cases} \max_i r_{ij}, & j \in \theta_{\max}, \\ \min_i r_{ij}, & j \in \theta_{\min}. \end{cases} \tag{5}$$

The alternative with the lowest value of t_i is the most appropriate alternative in this approach, i.e. alternatives are ranked based on t_i in ascending order.

The final ranking of the alternatives in the MOORA method is based on the dominance theory, i.e. the alternative with the highest number of appearances in the first positions on two ranking lists is the most appropriate alternative.

2.3. *The MULTIMOORA Method*

The MULTIMOORA method combines three approaches, where two are adopted from the MOORA method, as shown in Fig. 1. The third approach, named Full Multiplicative Form (FMF), calculates the ratio between ratings of beneficial and non-beneficial criteria as follows:

$$u_i = \frac{\prod_{j \in \theta_{\max}} w_j r_{ij}}{\prod_{j \in \theta_{\min}} w_j r_{ij}}, \tag{6}$$

where u_i denotes an overall utility of the alternative i.

The alternative with a higher value of u_i is the most appropriate alternative in this approach, i.e. alternatives are ranked based on u_i in descending order.

Similarly as in the MOORA method, as a result of the evaluation of the alternatives using the MULTIMOORA method, three ranking orders of alternatives are formed, obtained using three approaches, and the final ranking order, as well as the selection of the most suitable alternative, is made based on the dominance theory.

However, it should be noted that Dahooie *et al.* (2019) considered an approach for ranking alternatives that is not based on the dominance theory.

3. The MULTIMOOSRAL Method

The newly proposed MULTIMOOSRAL method integrates five approaches for ranking alternatives. In addition to the previously discussed approaches, applied in MOOSRA, MOORA and MULTIMOORA methods, the MULTIMOOSRAL method also includes
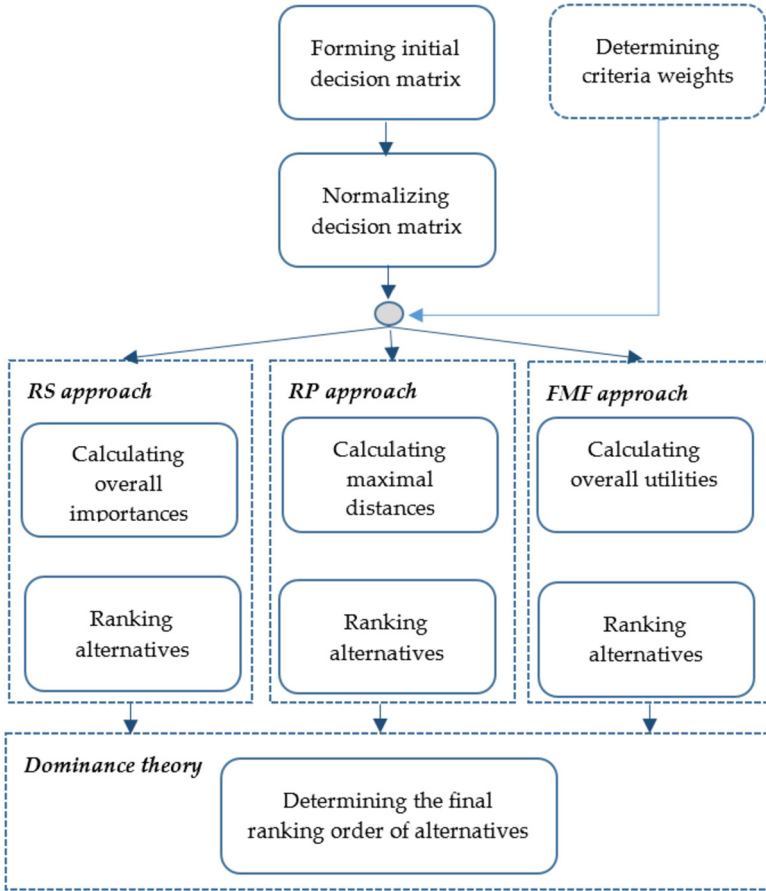
Fig. 1. Computational procedure of the MULTIMOORA method.

the LA approach. In addition, an important characteristic of MULTIMOOSRAL method can be mentioned, that is, it uses a new approach for determining the final ranking order of alternatives, which is not based on the dominance theory.

The computational procedure of the MULTIMOOSRAL method, presented in Fig. 2, can be precisely presented using the following steps:

Step 1. Forming the initial decision matrix and determining criteria weights.

Step 2. Forming the normalized decision matrix. The normalized decision matrix is formed using Eq. (7), which is:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n}(x_{ij})^2}}. \tag{7}$$

Step 3. Calculating the normalized overall utilities of alternatives based on the five approaches included in the MULTIMOOSRAL method, as follows:
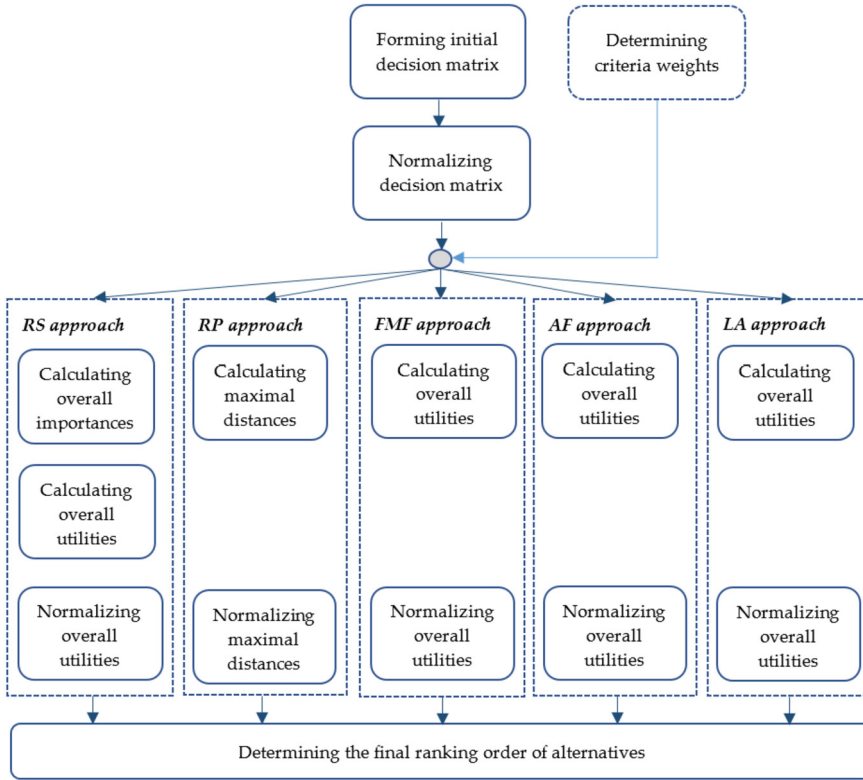
Fig. 2. Computational procedure of the MULTIMOOSRAL method.

Step 3.1. Determining the utility of alternatives based on the RS approach by applying the following substeps:

Substep 3.1.1. Calculating the overall importance of considered alternatives is performed using Eq. (8), which is:

$$y_i = \sum_{j \in \theta_{\max}} w_j r_{ij} - \sum_{j \in \theta_{\min}} w_j r_{ij}. \tag{8}$$

Substep 3.1.2. Calculating the overall utility of considered alternatives as follows:

$$m_i = \begin{cases} y_i, & \max_i(y_i) > 0, \\ y_i + 1, & \max_i(y_i) = 0, \\ -1/y_i, & \max_i(y_i) < 0, \end{cases} \tag{9}$$

where m_i denotes overall utility of alternative i obtained on the basis of RS approach.

Substep 3.1.3. Normalizing the overall utilities obtained on the basis of RS approach as follows:

$$m'_i = \frac{m_i - \min(m_i)}{\max(m_i) - \min(m_i)},$$ (10)

where m'_i denotes normalized overall utility of alternative i obtained on the basis of RS approach.

Step 3.2. Determining the utility of alternatives based on the RP approach by applying the following substeps:

Substep 3.2.1. Determining reference point r^* as follows:

$$r^* = (r^*_1, r^*_2, \ldots, r^*_n) = \left\{\max_i r_{ij} \,\big|\, j \in \theta_{\max}, \min_i r_{ij} \,\big|\, j \in \theta_{\min}\right\}.$$ (11)

Substep 3.2.2. Calculating the maximal distance between each alternative and the reference point using Eq. (12), which is:

$$t_i = \max_j\left(w_j \big| r^*_j - r_{ij} \big|\right).$$ (12)

Substep 3.2.3. Normalizing maximal distances as follows as follows:

$$t'_i = \frac{\max(t_i) - t_i}{\max(t_i) - \min(t_i)},$$ (13)

where t'_i denotes normalized overall utility of alternative i obtained on the basis of RP approach.

Step 3.3. Determining the utility of alternatives based on the FMF approach by applying the following substeps:

Substep 3.3.1. Calculating the overall utility of the alternatives using Eq. (14), which is:

$$u_i = \frac{\prod_{j \in \theta_{\max}} w_j r_{ij}}{\prod_{j \in \theta_{\min}} w_j r_{ij}}.$$ (14)

Substep 3.3.2. Normalizing the overall utilities obtained on the basis of FMF approach as follows:

$$u'_i = \frac{u_i - \min(u_i)}{\max(u_i) - \min(u_i)},$$ (15)

where u'_i denotes normalized overall utility of alternative i obtained on the basis of FMF approach.

Step 3.4. Determining the utility of alternatives based on an addition form (AF) approach by applying the following substeps:

Substep 3.4.1. Calculating the overall utility of each alternative using Eq. (16), which is:

$$v_i = \frac{\sum_{j \in \theta_{\max}} w_j r_{ij}}{\sum_{j \in \theta_{\min}} w_j r_{ij}}.$$ (16)

Substep 3.3.2. Normalizing the overall utilities obtained on the basis of AF approach as follows:

$$v'_i = \frac{v_i - \min(v_i)}{\max(v_i) - \min(v_i)}, \tag{17}$$

where v'_i denotes normalized overall utility of alternative i obtained on the basis of AF approach.

Step 3.5. Determining the utility of alternatives based on the LA approach by applying the following substeps:

Substep 3.5.1. Calculating the overall utility of alternatives based on the LA approach k_i as follows:

$$k_i = \sum_{j \in \theta_{\max}} \ln(1 + w_j r_{ij}) + \frac{1}{\sum_{j \in \theta_{\min}} \ln(1 + w_j r_{ij})}. \tag{18}$$

Substep 3.5.2. Normalizing the overall utilities obtained on the basis of AF approach as follows:

$$k'_i = \frac{k_i - \min(k_i)}{\max(k_i) - \min(k_i)}, \tag{19}$$

where k'_i denotes normalized overall utility of alternative i obtained on the basis of AF approach.

Step 4. Determining the final ranking orders of alternatives. The final ranking of alternatives is determined based on their total utility S_i, which is calculated as follows:

$$S_i = m'_i + t'_i + u'_i + v'_i + k'_i. \tag{20}$$

After that, the alternatives are ranked on the basis of values of S_i in descending order and the alternative with higher value of S_i is the most preferable.

4. An Illustrative Case Study

In this study the usability of the MULTIMOOSRAL method was demonstrated on supplier selection problem for a textile company. All data were collected from three managers of the company and the actual data of company. Managers of the company evaluated the criteria (indicated in Table 1) to obtain criteria weights. The evaluation criteria, as well as their weights (obtained by using the SWARA method, Keršuliene *et al.*, 2010), are shown in Table 1.

The data of the first three criteria are actual data and the data of the other criteria are obtained from managers of the company. The ratings of suppliers and normalized decision matrix are shown in Table 2 and Table 3.

Table 1
Evaluation criteria and their weights.

Criterion	Abbreviation	Weight	Type
Reject ratio	RjR	0.163	Non-beneficial
Purchasing cost	PCo	0.166	Non-beneficial
Late delivery ratio	LDT	0.161	Non-beneficial
Discount opportunity	DO	0.130	Beneficial
Technical assistance	TA	0.139	Beneficial
Technological capability	TecC	0.123	Beneficial
Supplier reputation	SRe	0.117	Beneficial

Table 2
Initial decision matrix.

Criteria suppliers	RjR	PCo	LDT	DO	TA	TecC	SRe
Supplier 1	0.02	2.64	0.02	6.3	7.7	7.3	8.3
Supplier 2	0.04	2.45	0.03	7	6.3	5	6.7
Supplier 3	0.04	2.40	0.04	6.7	6.3	5	6.7
Supplier 4	0.03	2.64	0.01	4.7	8.3	7.7	8
Supplier 5	0.04	2.26	0.04	7.7	5.7	7	7

Table 3
Normalized decision matrix.

Criterian suppliers	RjR	PCo	LDT	DO	TA	TecC	SRe
Supplier 1	0.256	0.476	0.294	0.430	0.497	0.502	0.504
Supplier 2	0.513	0.441	0.441	0.477	0.407	0.344	0.407
Supplier 3	0.513	0.432	0.588	0.457	0.407	0.344	0.407
Supplier 4	0.385	0.476	0.147	0.321	0.536	0.529	0.485
Supplier 5	0.513	0.407	0.588	0.525	0.368	0.481	0.425

Table 4
Computational details obtained on the basis of RS approach.

Suppliers	Overall importance	Overall utility	Normalized overall utility
Supplier 1	0.078	0.078	1.000
Supplier 2	−0.019	−0.019	0.211
Supplier 3	−0.045	−0.045	0.000
Supplier 4	0.073	0.073	0.959
Supplier 5	−0.019	−0.019	0.211

The overall importance of alternatives, overall utilities and normalized overall utilities obtained on the basis of RS approach, calculated by Eqs. (8), (9) and (10), are shown in Table 4.

The reference point, obtained using Eq. (11) and data from Table 3, is shown in Table 5.

After that, the maximal distances and normalized maximal distances are calculated, using Eq. (12) and Eq. (13), as shown in Table 6.

The overall utility and normalized overall utility of alternatives obtained on the basis of FMF approach, using Eqs. (14) and (15), are shown in Table 7.

Table 5
The reference point.

	RjR	PCo	LDT	DO	TA	TecC	SRe
$r*$	0.256	0.407	0.147	0.525	0.536	0.529	0.504

Table 6
Computational details obtained on the basis of RP
approach.

Suppliers	Maximal distance	Normalized maximal distance
Supplier 1	0.024	1.000
Supplier 2	0.047	0.511
Supplier 3	0.071	0.000
Supplier 4	0.027	0.936
Supplier 5	0.071	0.000

Table 7
Computational details obtained on the basis of FMF
approach.

Suppliers	Overall utility	Normalized overall utility
Supplier 1	0.0906	0.918
Supplier 2	0.0164	0.053
Supplier 3	0.0118	0.000
Supplier 4	0.0977	1.000
Supplier 5	0.0189	0.082

Table 8
Computational details obtained on the basis of AF
approach.

Suppliers	Overall utility	Normalized overall utility
Supplier 1	1.4643	1.000
Supplier 2	0.9167	0.149
Supplier 3	0.8207	0.000
Supplier 4	1.4398	0.962
Supplier 5	0.9231	0.159

The overall utility and normalized overall utility of alternatives obtained on the basis of AF approach, using Eqs. (16) and (17), are shown in Table 8.

The overall utility and normalized overall utility of alternatives obtained on the basis of LA approach, using Eqs. (18) and (19), are shown in Table 9.

Finally, in Table 10 results obtained using five approaches integrated in MULTI-MOOSRAL method, overall utility of considered alternatives, calculated using Eq. (20), and ranking order of alternatives are presented.

Table 9
Computational details obtained on the basis of LA
approach.

Suppliers	Overall utility	Normalized overall utility
Supplier 1	6.3697	0.962
Supplier 2	4.7551	0.193
Supplier 3	4.3512	0.000
Supplier 4	6.4490	1.000
Supplier 5	4.4375	0.041

Table 10
Computational details obtained using the MULTIMOOSRAL method.

Suppliers	m_i'	t_i'	u_i'	v_i'	k_i'	S_i	Rank
Supplier 1	1.000	1.000	0.918	1.000	0.962	4.880	1
Supplier 2	0.211	0.511	0.053	0.149	0.193	1.117	3
Supplier 3	0.000	0.000	0.000	0.000	0.000	0.000	5
Supplier 4	0.959	0.936	1.000	0.962	1.000	4.857	2
Supplier 5	0.211	0.000	0.082	0.159	0.041	0.494	4

Table 11
Ranking of alternatives using the MOOSRA method.

Suppliers	v_i	Rank
Supplier 1	1.4643	1
Supplier 2	0.9167	4
Supplier 3	0.8207	5
Supplier 4	1.4398	2
Supplier 5	0.9231	3

Table 12
Ranking of alternatives using the MOORA method.

Suppliers	RS	RS Rank	RP	RP Rank	Rank
Supplier 1	0.078	1	0.024	1	1
Supplier 2	−0.019	3	0.047	3	3
Supplier 3	−0.045	5	0.071	4	4–5
Supplier 4	0.073	2	0.027	2	2
Supplier 5	−0.019	4	0.071	4	4

As it can be seen from Table 10, the best supplier selected using the MULTIMOOS-RAL method is supplier denoted as "Supplier 1".

In order to further verify the obtained results, a comparison with the results obtained using the MOOSRA, MOORA and MULTIMOORA methods was performed below. The results obtained using the above methods are shown in Tables 11, 12 and 13.

From Tables 11, 12 and 13 it can be seen that the ranking results obtained using the MULTIMOOSRAL method are identical to the results obtained using the MOOSRA, MOORA and MULTIMOORA methods.

Table 13
Ranking of alternatives using the MULTIMOORA method.

Suppliers	RS	RS Rank	RP	RP Rank	FMF	FMF Rank	Rank
Supplier 1	0.078	1	0.024	1	0,0906	2	1
Supplier 2	−0.019	3	0.047	3	0,0164	4	3
Supplier 3	−0.045	5	0.071	4	0,0118	5	5
Supplier 4	0.073	2	0.027	2	0,0977	1	2
Supplier 5	−0.019	4	0.071	4	0,0189	3	4

Table 14
Comparative analysis of ranking orders obtained using different MCDM
methods.

Suppliers	MULTIMOOSRAL	TOPSIS	MULTIMOORA	CoCoSo
Supplier 1	1	1	1	1
Supplier 2	3	3	3	3
Supplier 3	5	5	5	4
Supplier 4	2	2	2	2
Supplier 5	4	4	4	5

In order to finally verify the results obtained using the MULTIMOOSRAL method, a comparative analysis was performed with several well-known MCDM methods, such as TOPSIS, MULTIMOORA, and CoCoSo methods, as shown in Table 14.

It can be observed from Table 14, that the MULTIMOOSRAL method gives the same ranking orders as the TOPSIS and MULTIMOORA methods. Some discrepancy in the rank of the alternative can be observed in the case of the use of the CoCoSo method, which refers to the fourth and fifth-ranked alternatives. However, such phenomena are expected because the newly proposed MULTIMOOSRAL method integrates more ranking approaches and because of that, it should allow a more accurate ranking of the alternatives.

5. Conclusions

This paper proposes a new MCDM technique called MULTIMOOSRAL that is based on the approaches in MOOSRA, MOORA, and MULTIMOORA methods and LA approach for the facilitation of a decision-making process. The main incentive for proposing the new method reflects the desire to develop such an approach that will contribute to the increasing of the credibility of the obtained results. In this case, by involving five approaches (RS, RP, FMF, AF, and LA) the reliability of the final ranking order as well as its stability is raised to a higher level.

In order to demonstrate the applicability and usefulness of the proposed method, the illustrative case study pointed to the selection of the adequate supplier of the textile company is presented. The evaluation process, entrusted to 3 managers, is based on the 7 criteria and 5 alternatives. The gained result revealed that supplier 1 is the most suitable to work within the present conditions, while supplier 3 is the worst choice according to the given performances.

To acknowledge the reliability of the obtained ranking order, the MOOSRA, MOORA, and MULTIMOORA methods are applied. The results from all three used techniques confirmed that one was obtained by using the newly proposed MULTIMOOSRAL method. Namely, in all three observations, supplier 1 is ranked as the best alternative, while supplier 3 is ranked as the last and worst option. In this way, the stability of the proposed MCDM method is verified as well as its suitability for applying in the decision-making process.

Although this novel method contributes to the reliability of the performed decision process by involving more approaches, the same thing could be considered as its main deficiency, too. Namely, the computational procedure could be considered as complex for application by the users that are not familiar with the MCDM field. Additionally, in order to better incorporate the uncertainty, this model could be extended by involving the fuzzy, grey, or neutrosophic numbers. But, despite the mentioned imperfections, the MULTI-MOOSRAL method proved its efficiency in enhancing the decision-making process and its possibilities should be further examined.

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